Using Big Data To Solve Economic and Social Problems

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Photo Credit: Florida Atlantic University

Government Intervention in Markets for Health Insurance

- Data show that insurance coverage leads to moderate increases in health care use and improvement in health outcomes
- Suggests that access to health insurance can be valuable for improving population health
- But does not necessarily follow that government needs to provide this insurance
  - Why can’t people buy it themselves in private markets, like they do other products like cars?

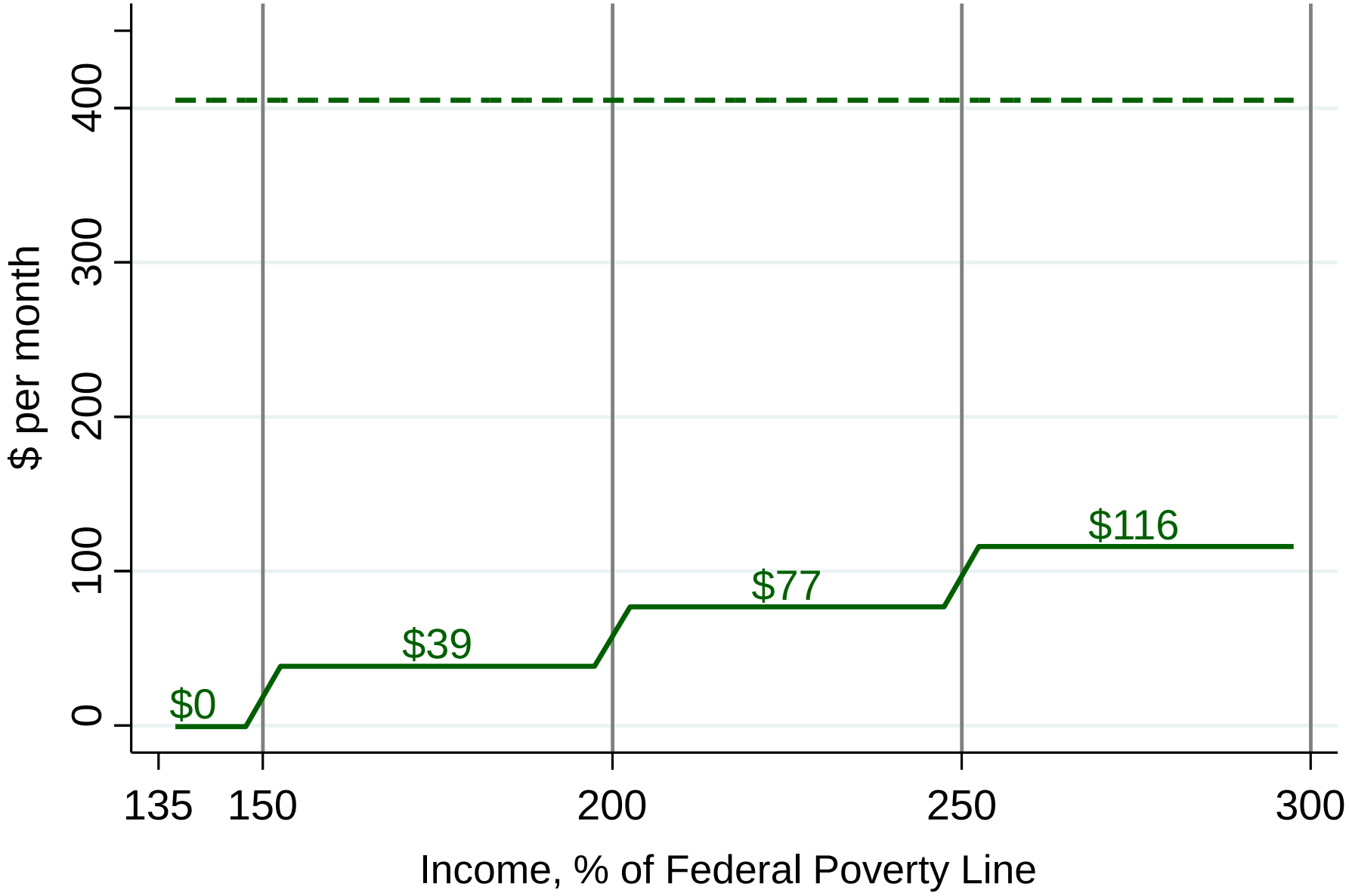
Demand for Health Insurance

- Finkelstein, Hendren, and Shepard (2017) show why government intervention is essential to sustain markets for insurance

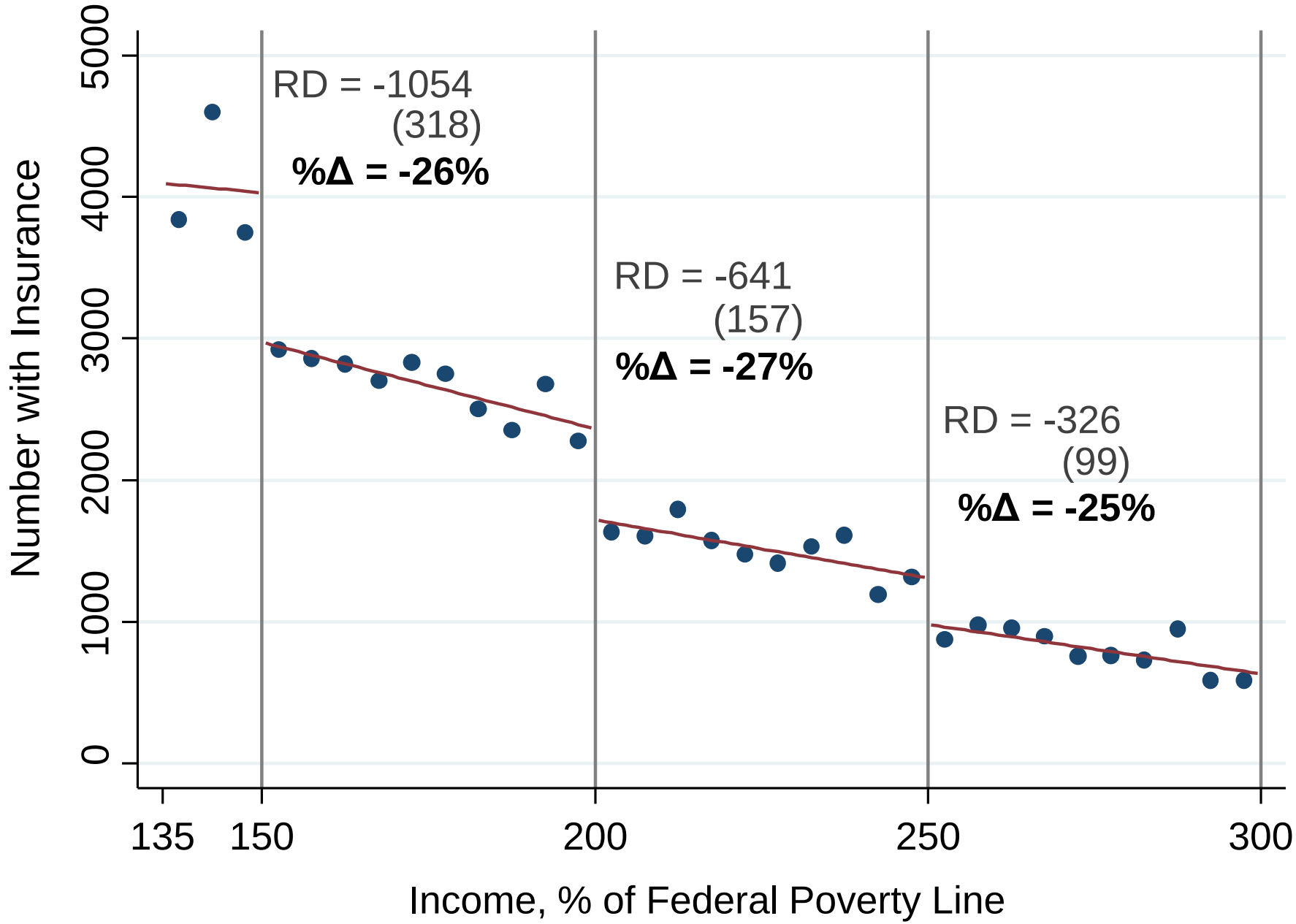
- Study Massachusetts public universal health insurance program
  - Introduced in 2006; predecessor to the national Affordable Care Act

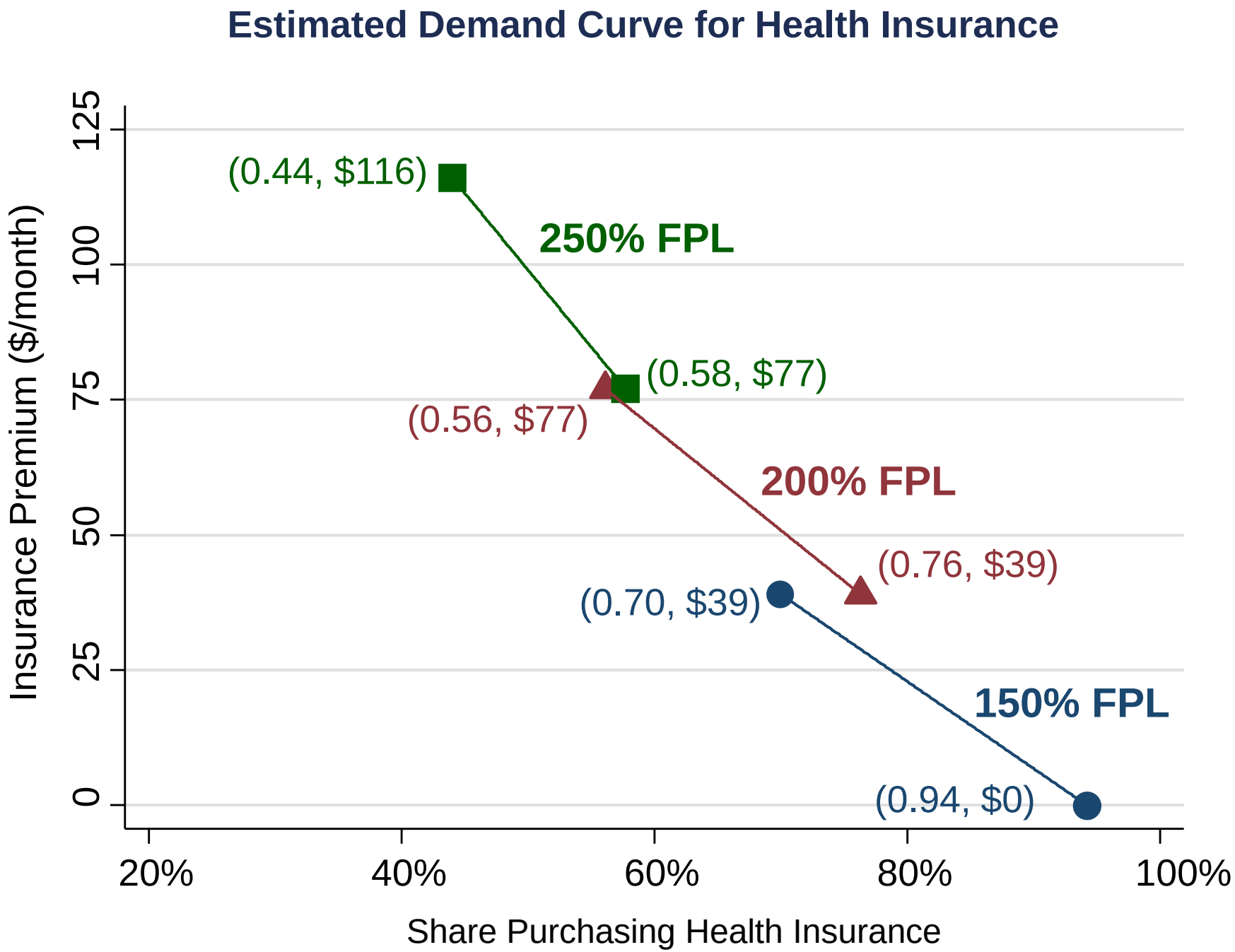
- Research design: exploit discontinuities in subsidies for insurance based on income level

Subsidy and Premium Discontinuities in Massachusetts in 2011



Number of Individuals Enrolled in a Health Insurance Plan by Income Level

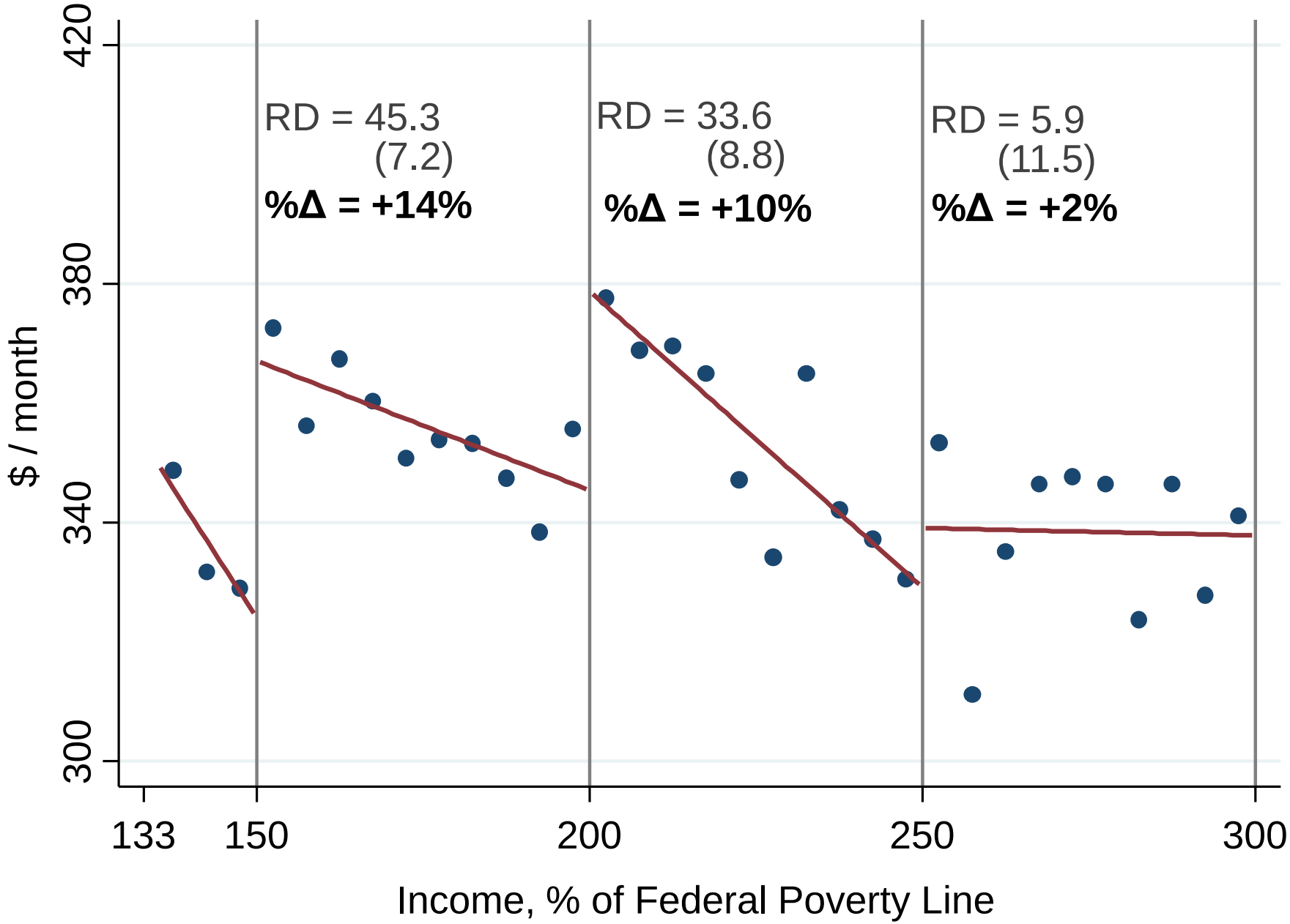



Estimated Demand Curve for Health Insurance
Insurance Premium ($/month)
0
25
50
75
100
125
20%
40%
60%
80%
100%
Share Purchasing Health Insurance
(0.44, $116)
250% FPL
(0.58, $77)
(0.56, $77)
200% FPL
(0.76, $39)
(0.70, $39)
150% FPL
(0.94, $0)

Demand for Health Insurance

- Demand for health insurance among the poor falls very rapidly as price rises
  - Reducing subsidies would drastically reduce the number of individuals insured
- Moreover, *sicker* people remain insured, increasing average costs for insurers (“adverse selection”)

Adverse Selection: Average Costs Paid by Insurance Companies



Lessons on Markets for Health Insurance

- Government intervention is critical to sustain markets for health insurance for two reasons:

  1. Low-income individuals are very sensitive to price → will not buy insurance if not subsidized or provided by government

  2. Healthiest low-income individuals are least likely to buy → insurance companies get stuck with higher costs, making market collapse

- Hendren: Trumpcare would effectively end enrollment in insurance markets for families that make less than $75,000 a year

The New Study That Shows Trumpcare's Damage

David Leonhardt MAY 3, 2017

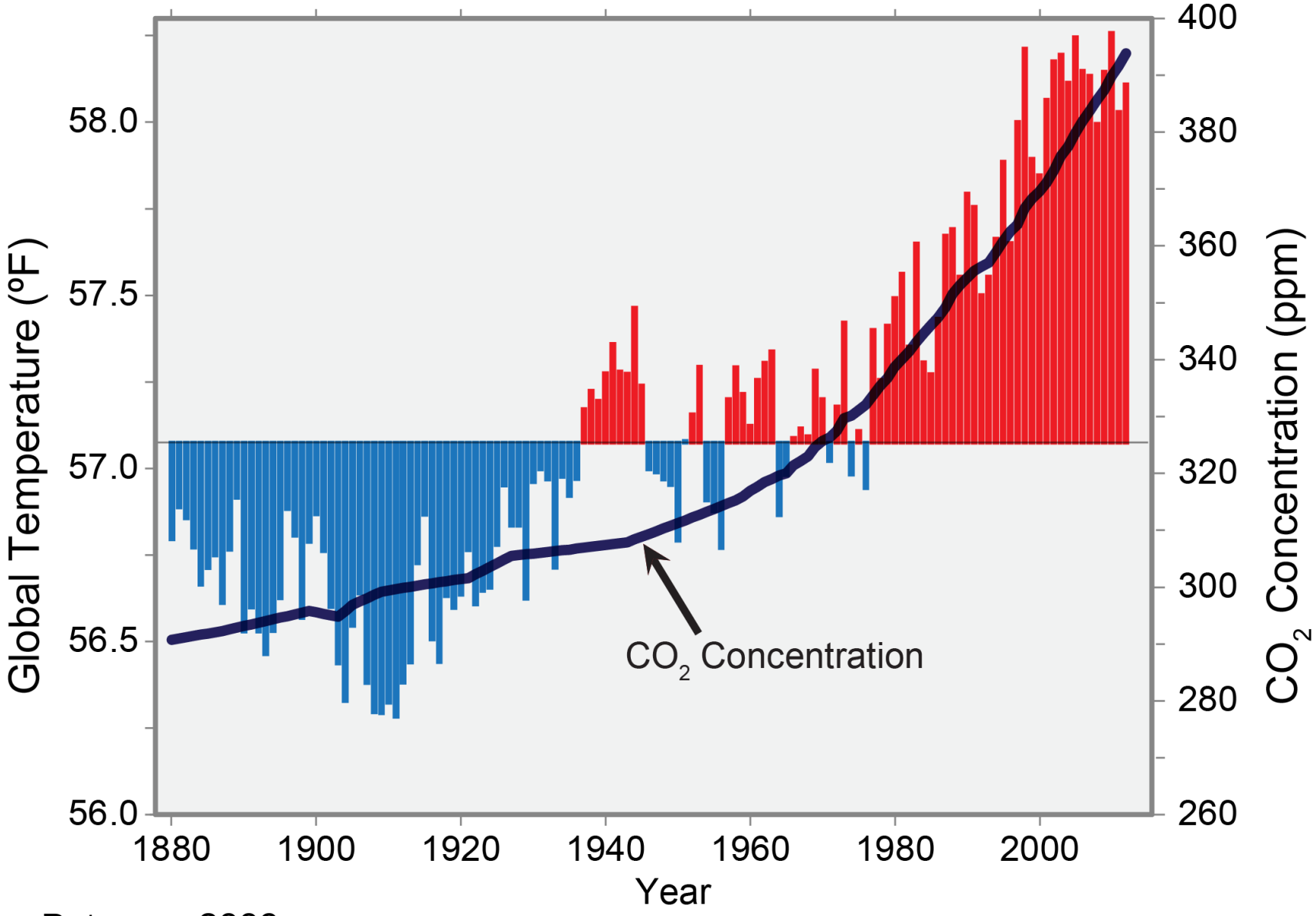
From left, Republican representative Fred Upton, Michael Burgess, Greg Walden and Billy Long after meeting with President Trump on Wednesday. Stephen Crowley/The New York Times

When Massachusetts expanded health insurance a decade ago, state officials unknowingly created an experiment. It's turned out to be an experiment that offers real-world evidence of what would happen if the House Republicans' health bill were to become law.

The findings from Massachusetts come from an academic paper being released Thursday, and the timing is good. Until now, the main analysis of the Republican health bill has come from the Congressional Budget Office, and some Republicans have criticized that analysis as speculative. The Massachusetts data is more concrete.

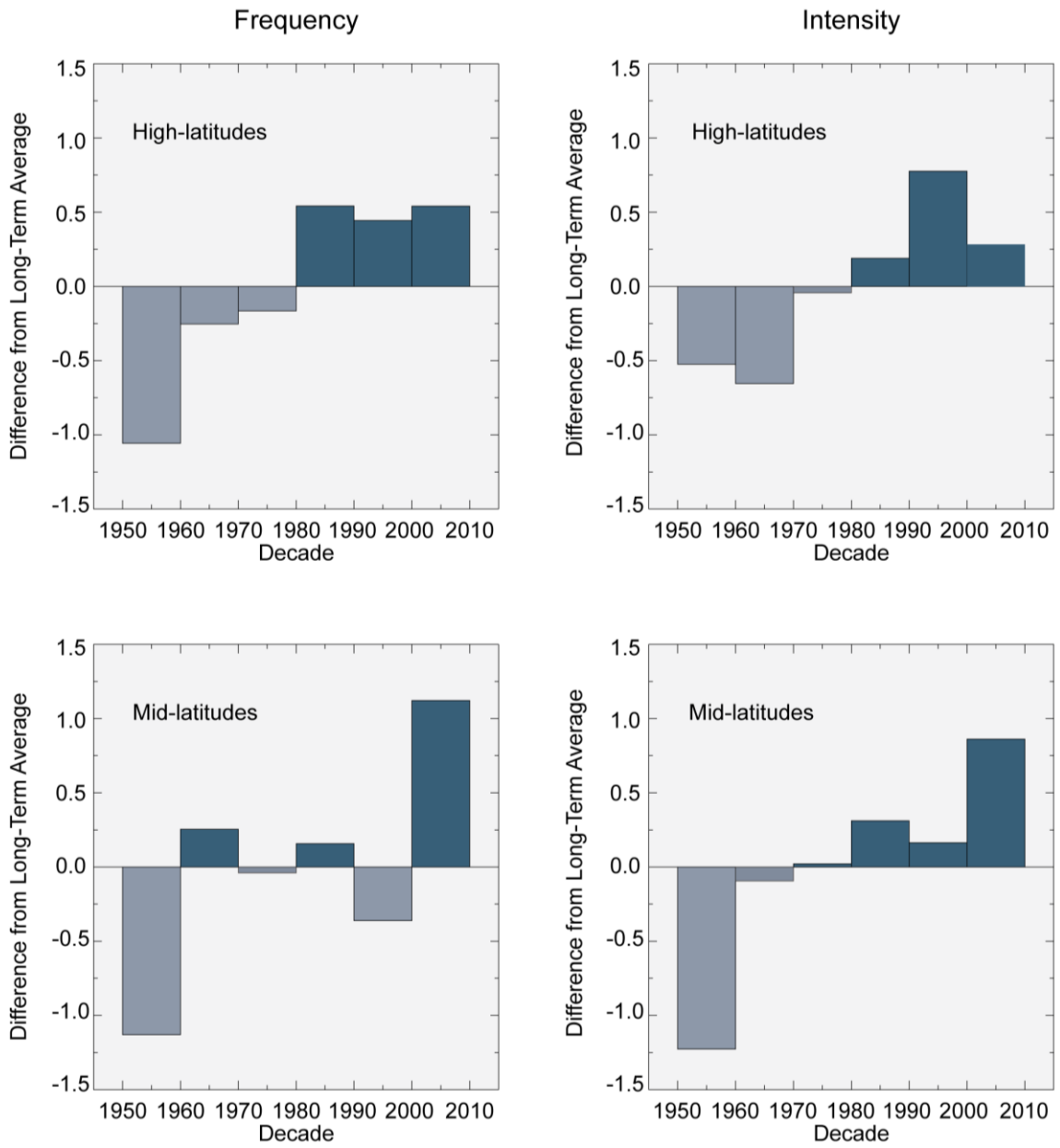
Environmental Economics

Trends in Global Temperature and Carbon Dioxide Concentration



Source: Karl, Melillo, Peterson 2009

Trends in Frequency and Intensity of Winter Storms



Source: CCSP 2008

Climate Change and Environmental Economics

- Idealistic response to dramatic change in climate: we should preserve environment in its original state, no matter the cost

- Environmental economists take a more practical perspective

  1. Tradeoff between economic benefits and environmental costs → need to price environmental damage created by each policy to more forward

  2. Humans have adapted in the past (e.g., using air-conditioning), mitigating costs of environmental change

Climate Change and Environmental Economics

- Example: building a new oil pipeline or permitting fracking for gas
  - These policies could have significant benefits by reducing costs of resources and effectively increasing people's incomes
  - What is the environmental damage created by these policies?
- Big data is helping us make progress in answering this question
  - New data permits more effective comparison of alternative policies
  - And helps us find ways to preserve the environment while minimizing economic costs

Conceptual Background: Social Problems

- Final two topics in this course (environment and crime) are social problems because they involve **externalities**

- Externality: one person's behavior directly affects another person's well-being
  - Ex: You drive a car that emits pollution → everyone pays a price

- Different from the outcomes we have considered thus far
  - Income, education, health: benefits accrue primarily to a given individual

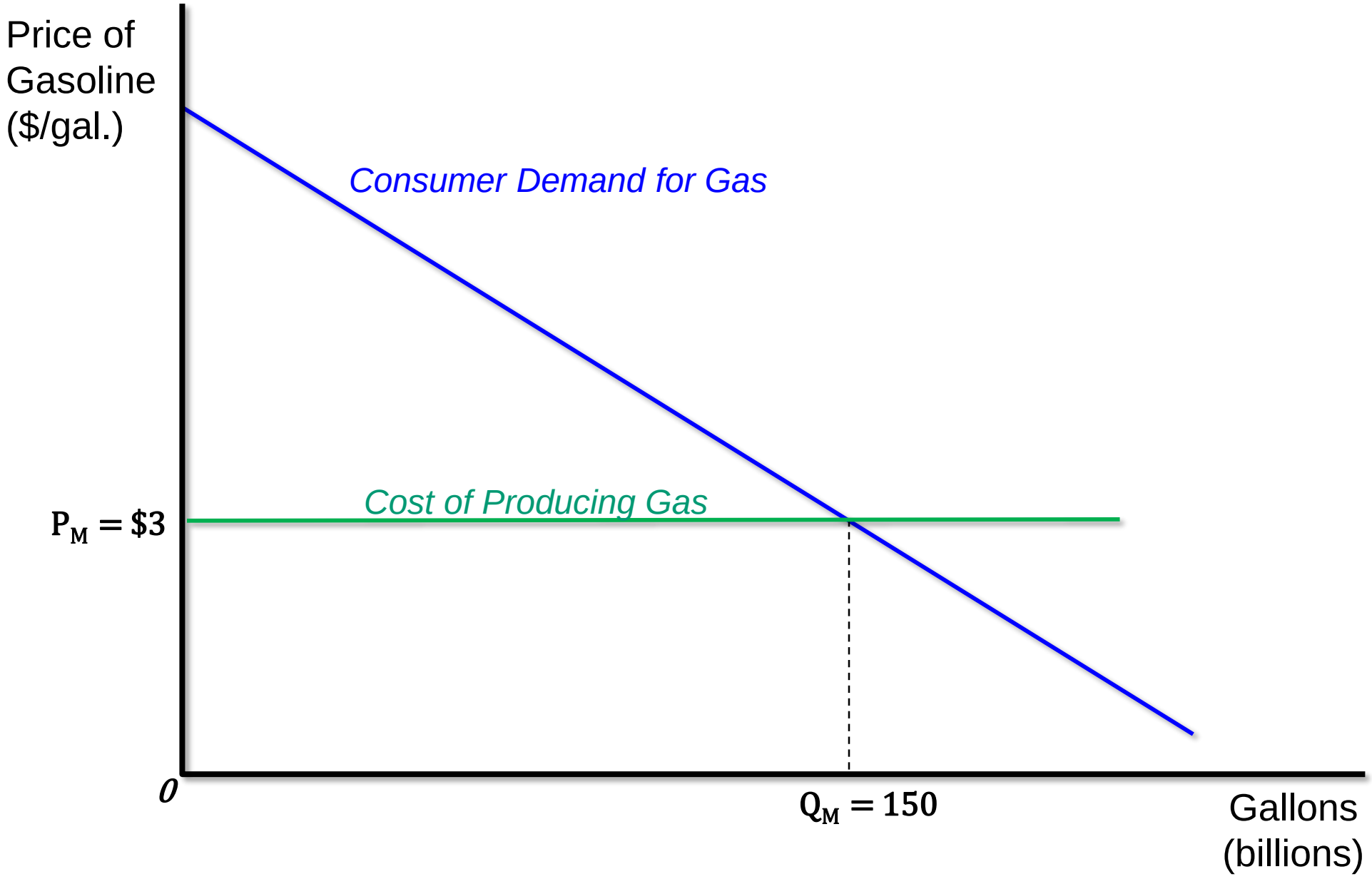
Conceptual Background: Social Problems

- Tackling social problems requires different types of data and methods

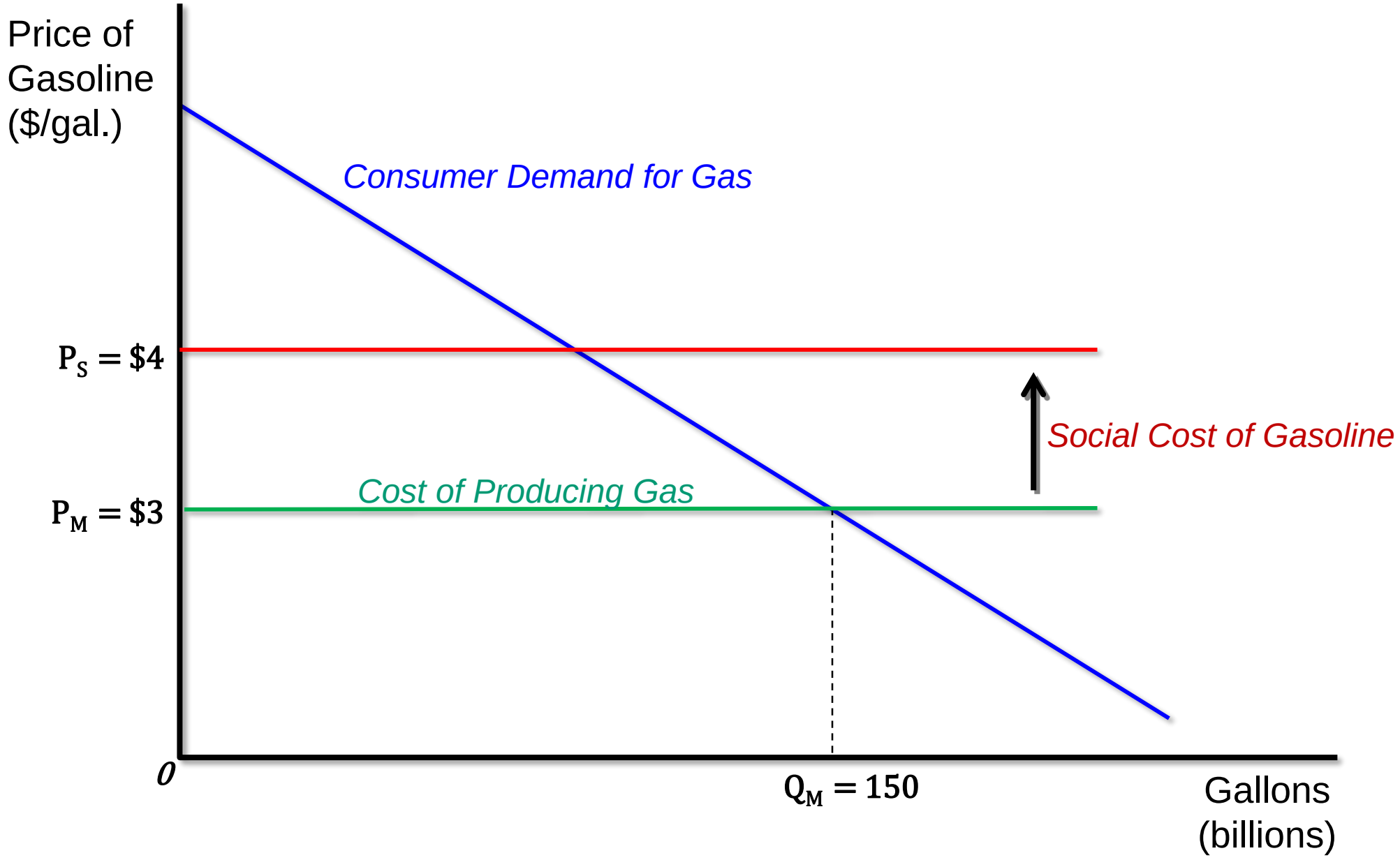
- Need to measure impacts on *everyone,* not just on a given person's income or health
  - Contrast with analysis of impacts of class size on students' test scores
  - Group-centric rather than individual-centric empirical analysis

- Goal is to change people's behavior to move *away* from what is best for them personally
  - Contrast with college outreach programs
  - Focus on changing behavior to achieve *social* aims rather than individual benefits

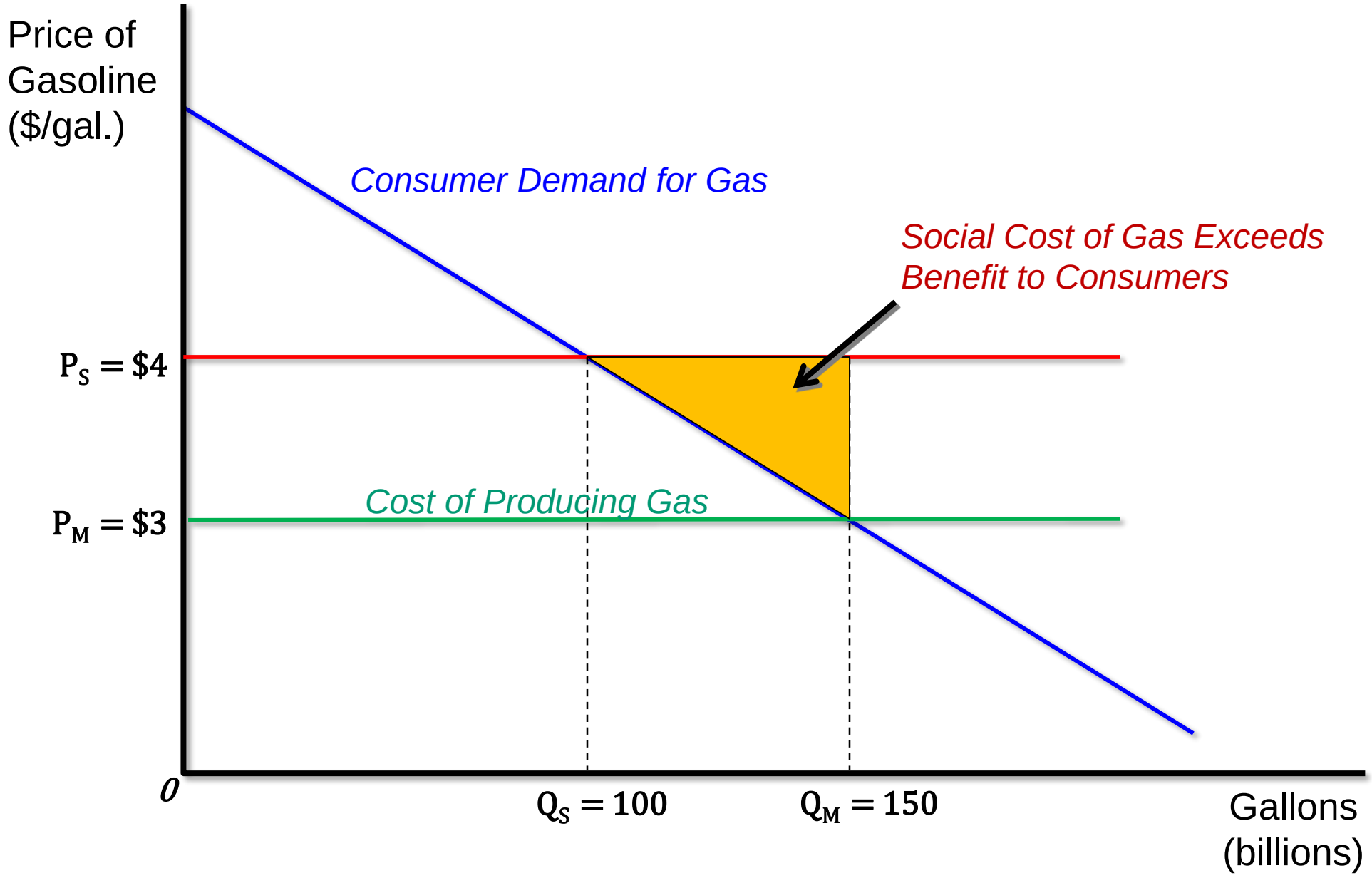
Economics of Externalities



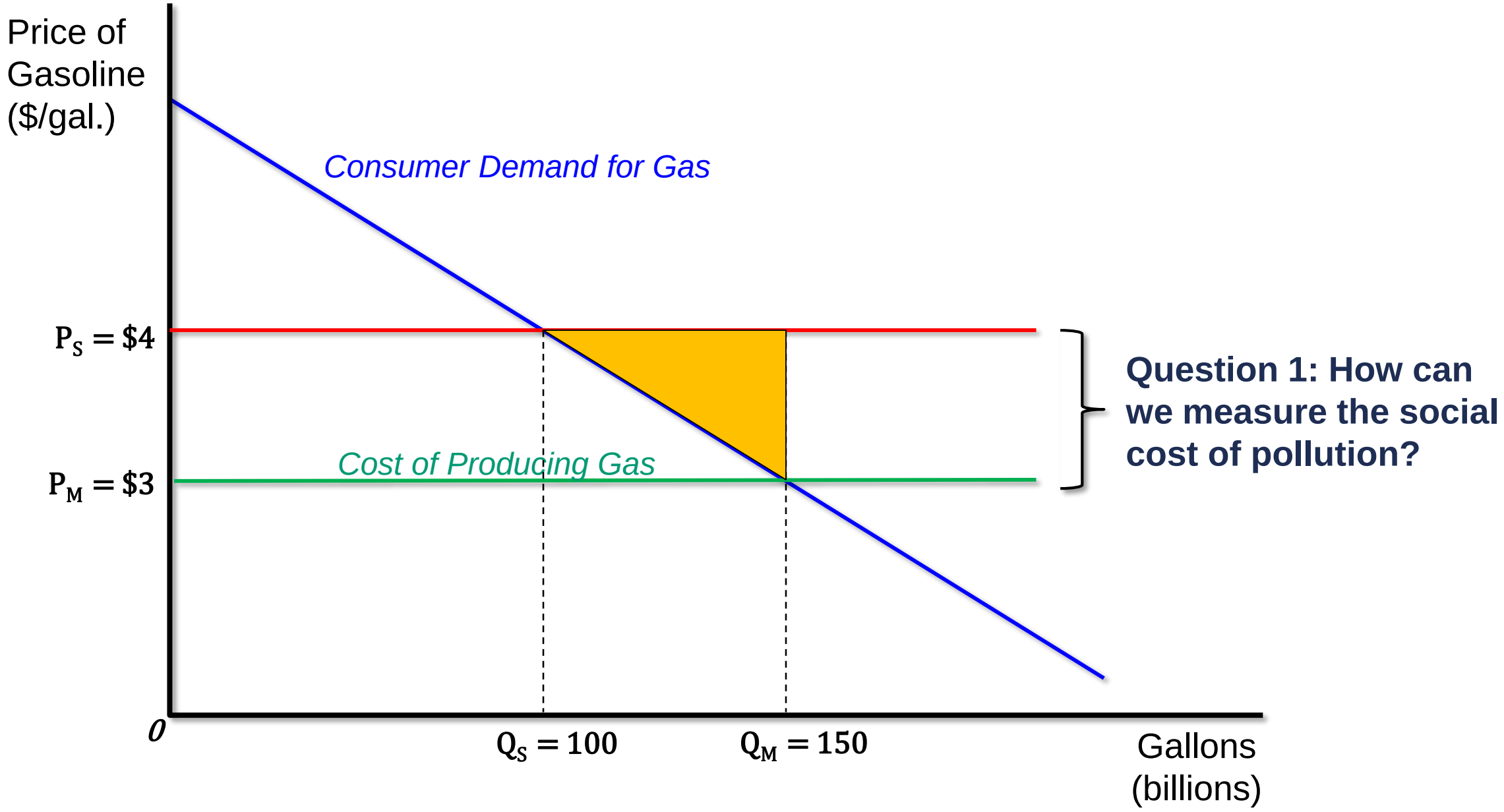
Economics of Externalities



Economics of Externalities

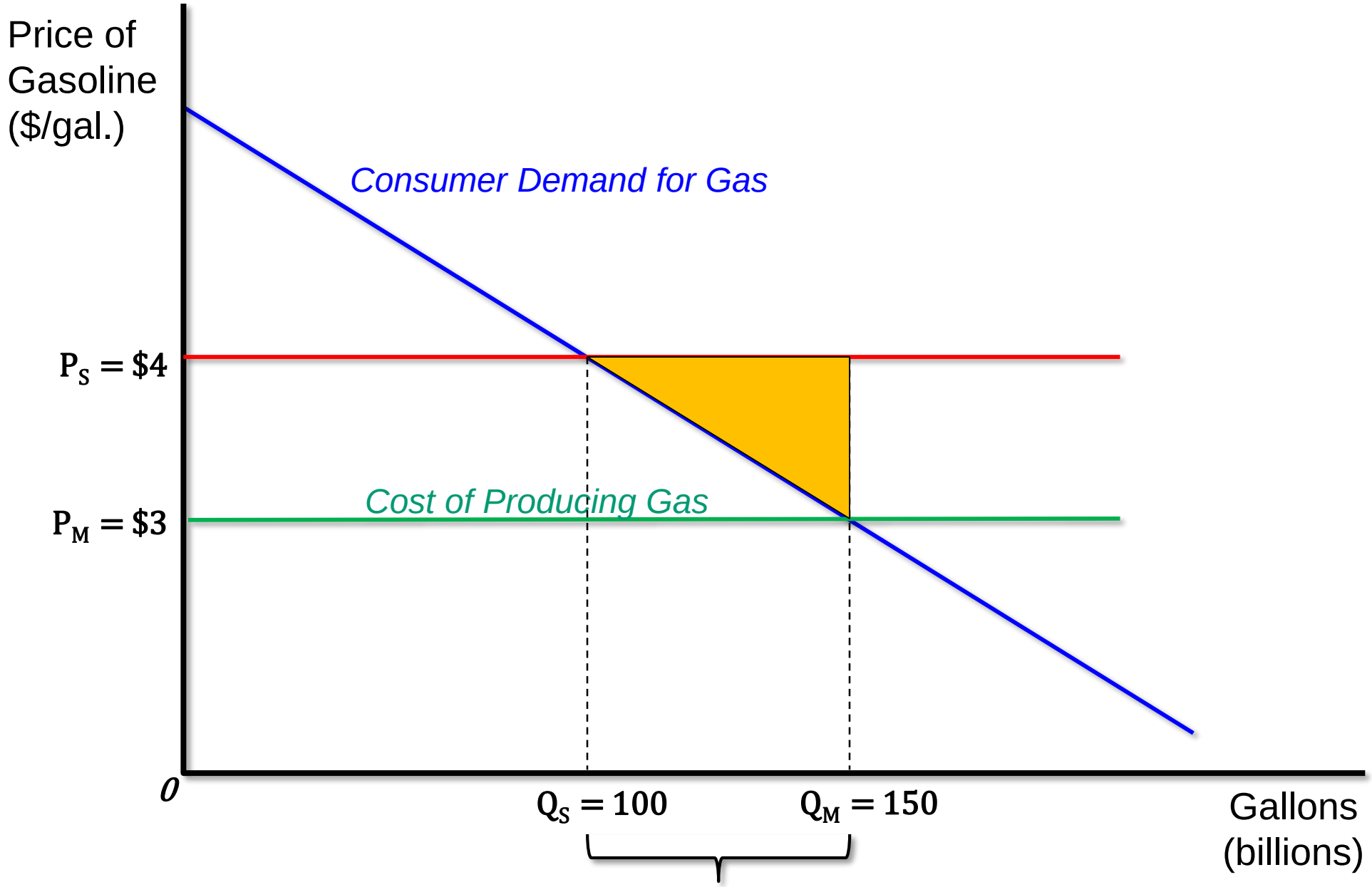


Two Key Questions in Environmental Economics



Question 1: How can we measure the social cost of pollution?

Two Key Questions in Environmental Economics



Question 2: What policies can we use to reduce pollution/improve environment?

Social Costs of Climate Change and Pollution

Social Cost of Carbon

- Researchers have estimated social costs of many different types of pollution, ranging from toxic air pollution to water pollution
- Given link between CO_2 emissions and climate change, carbon emissions have received the most attention
- Governments now use estimates of “social cost of carbon” when evaluating alternative policies
- Conceptual question: how much does an additional unit of carbon emissions cost society due to environmental damage?
    - Calculating this cost is challenging and is the subject of much research

Estimating the Social Cost of Carbon

- Three general steps in estimating the social cost of carbon:

  1. Predict impact of 1 extra ton of CO_2 on climate using a climate forecasting model

  2. Measure impacts of changes in climate on economic productivity, health, property damage, etc.

  3. Calculate current social cost by converting future costs to current dollars (discounting)

- First question is the subject of research in environmental science

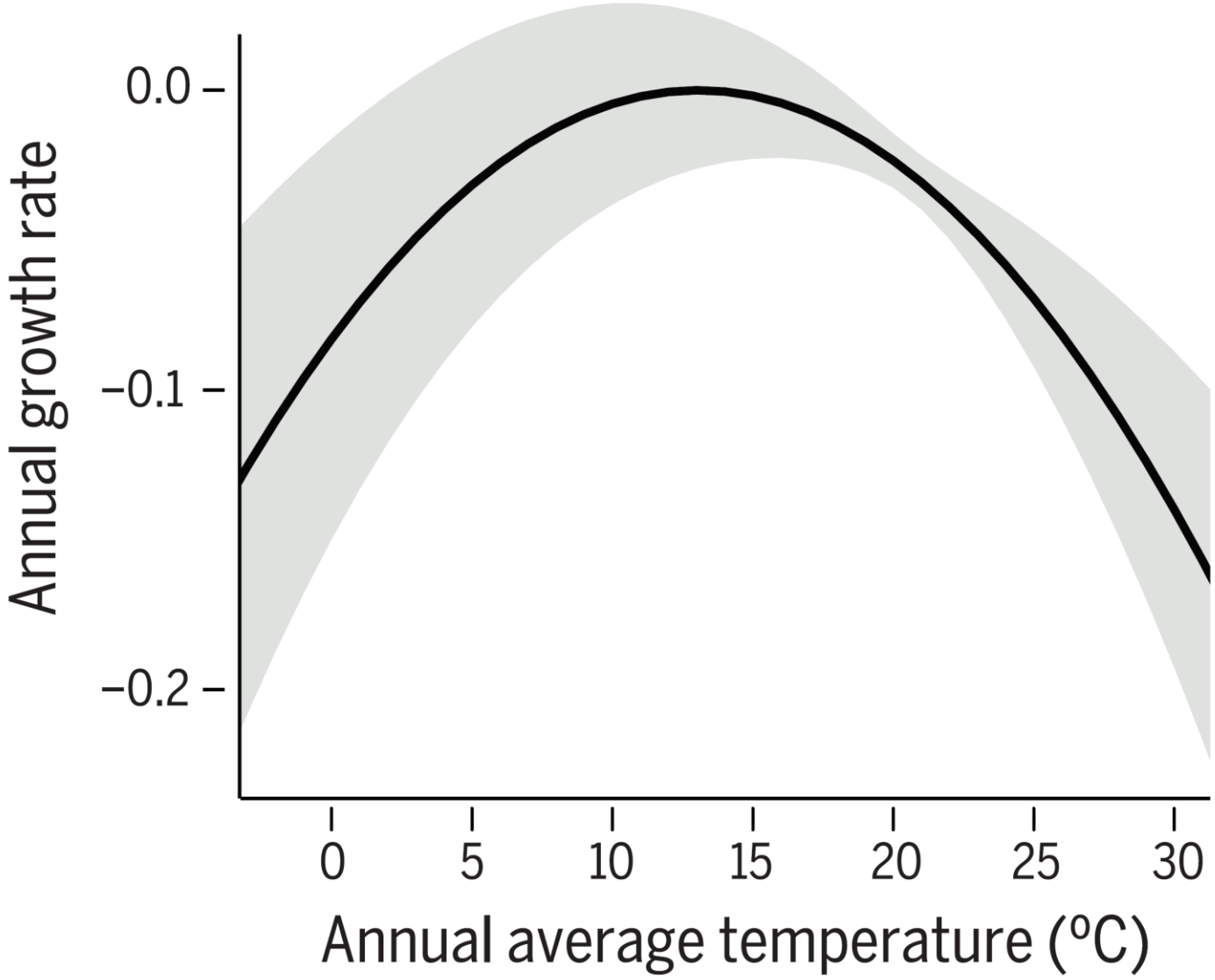
- Focus here on how big data is enabling social scientists to obtain better answers in steps 2 and 3

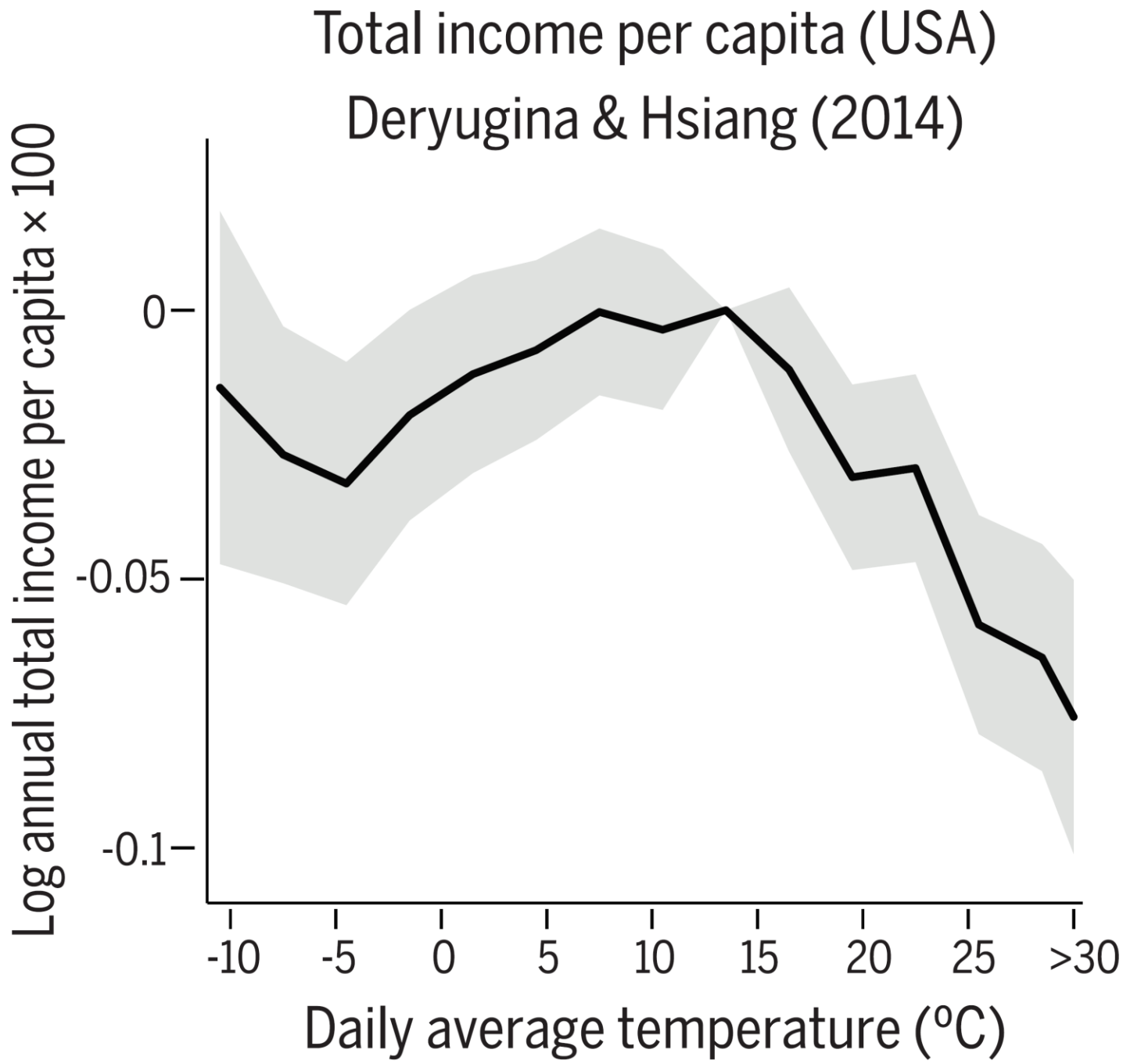
Estimating the Impacts of Climate Change

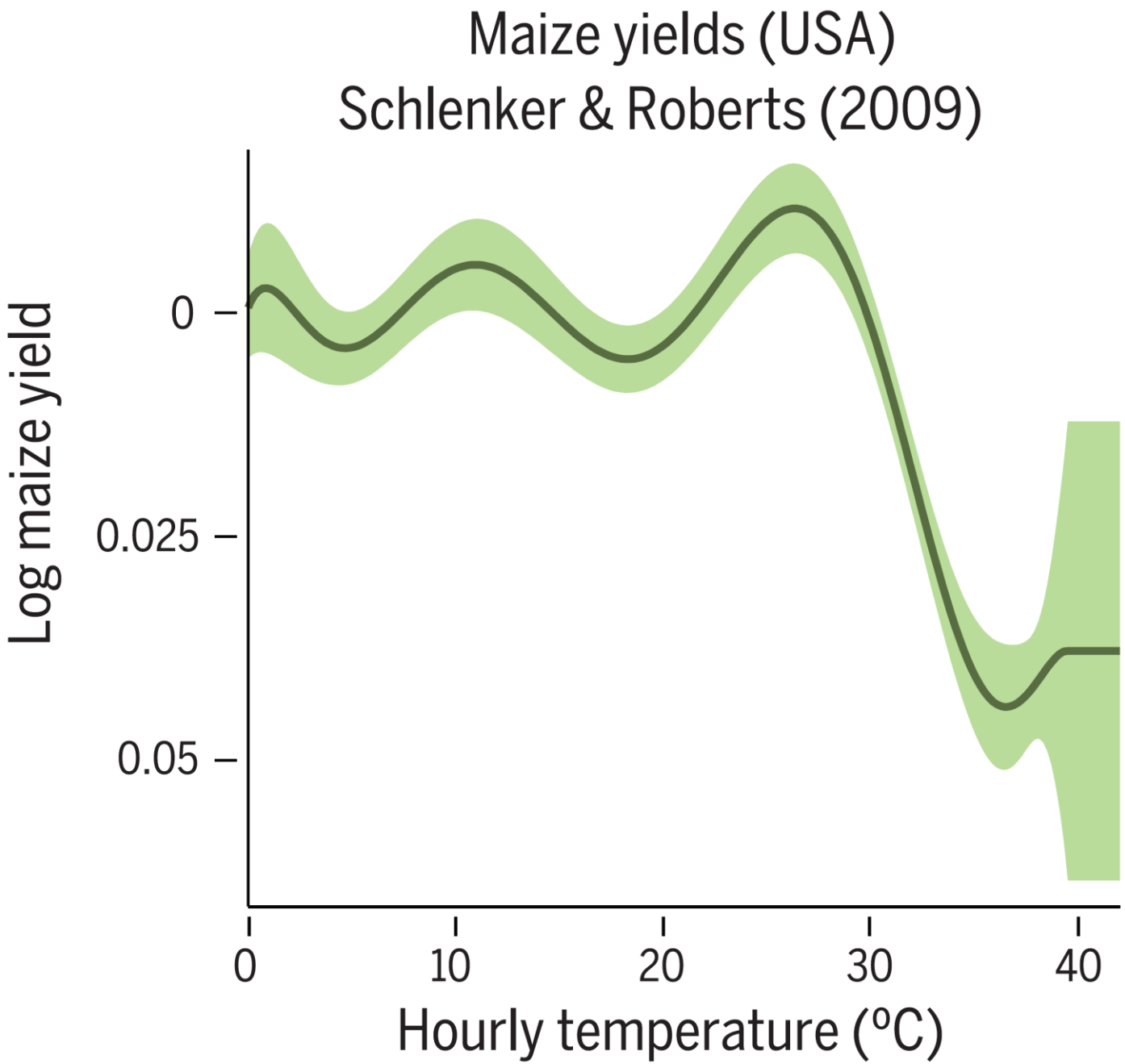
- Recent studies estimate causal impacts of climate change on many outcomes
  - Combine data on outcomes from various sources with detailed measurements of temperature from local monitors
- General approach: estimate models that relate outcomes to temperature fluctuations across days or years
  - Comparisons across time *within* areas, not comparisons across areas
  - Temperature variation random within areas → identify causal effects
  - Note that this picks up short-run effects, ignoring potential for adaptation
- Carleton and Hsiang (2016) compile results of several of these studies

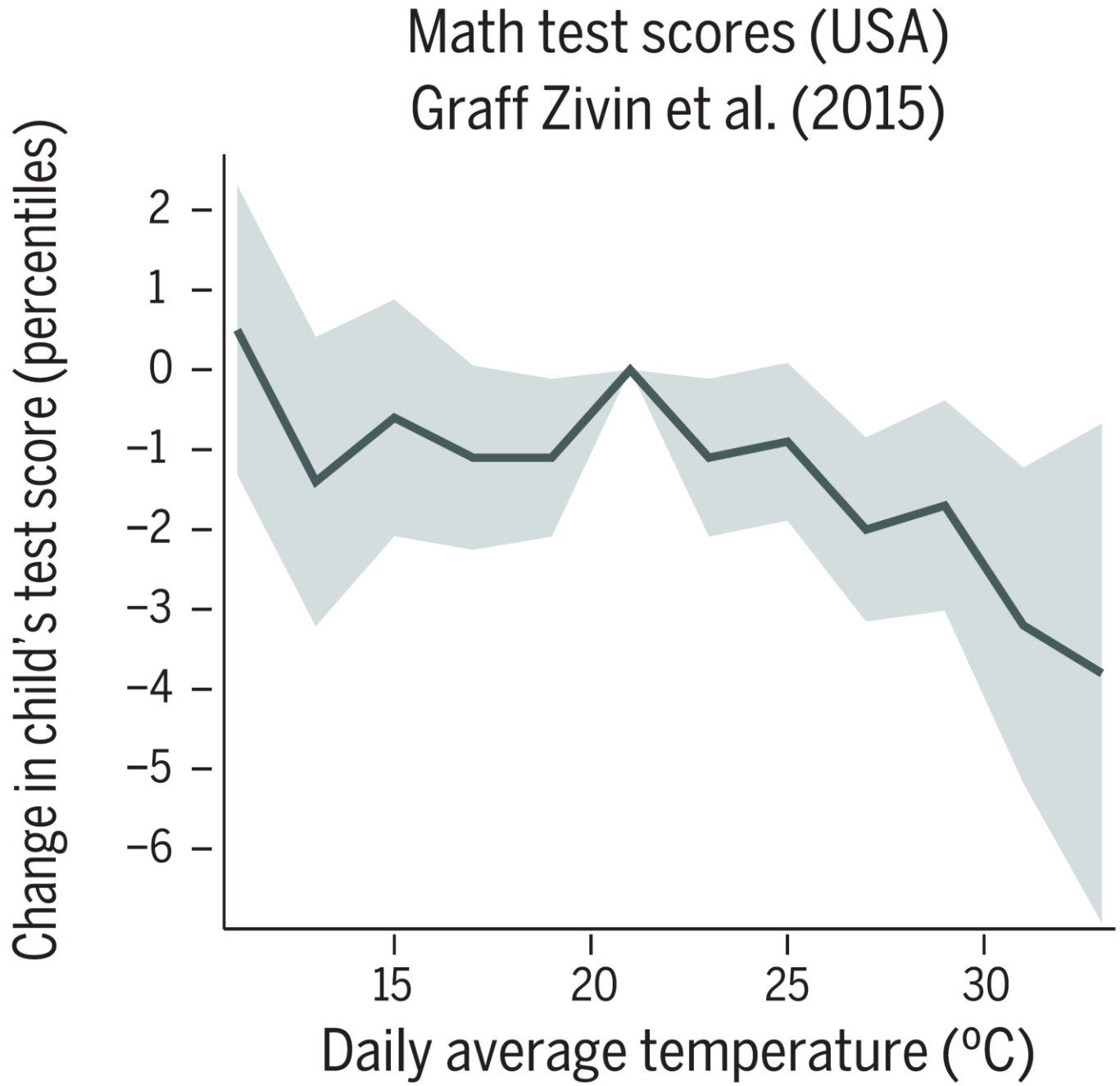
Gross domestic product per capita (global)

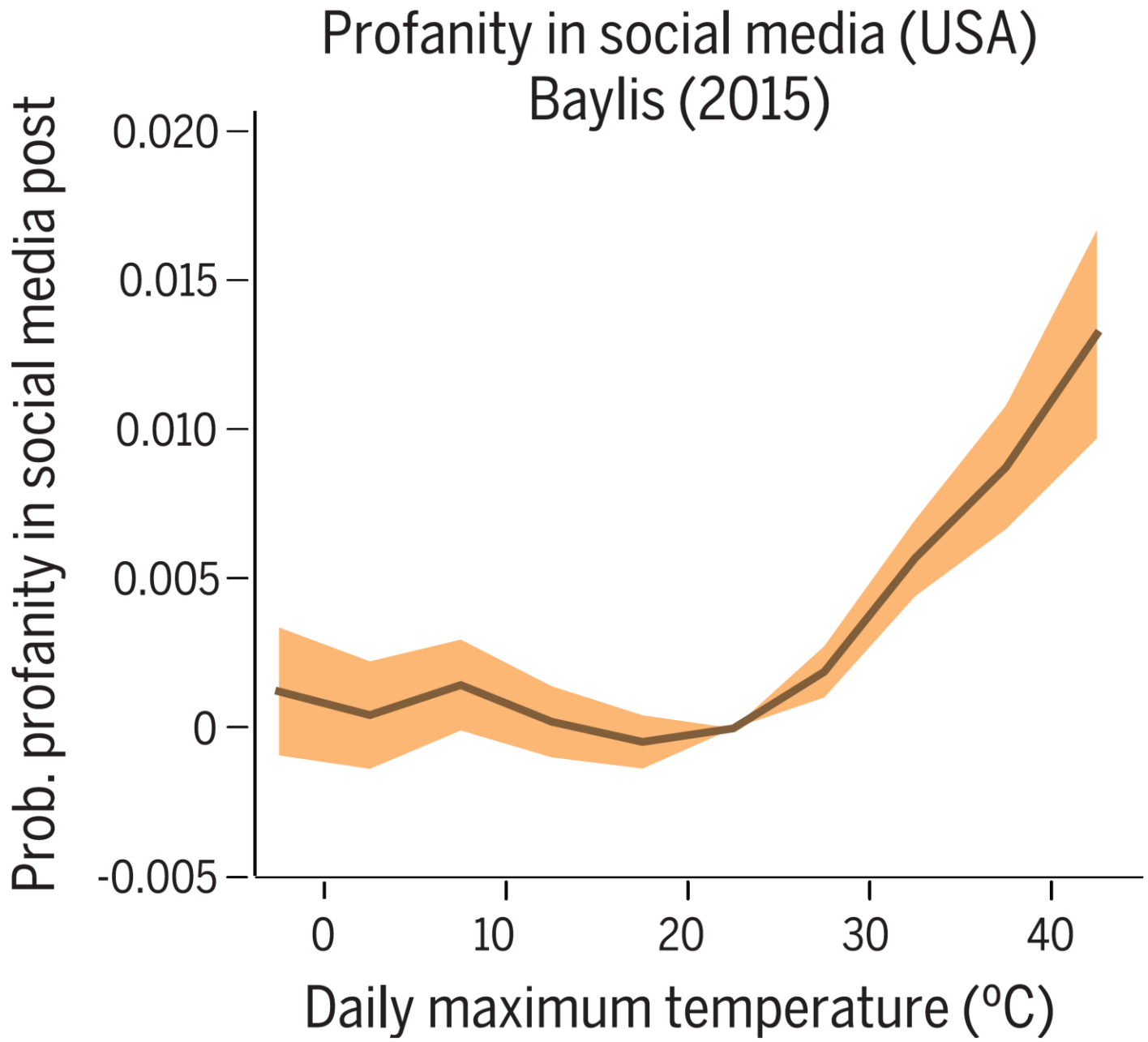
Burke et al. (2015)

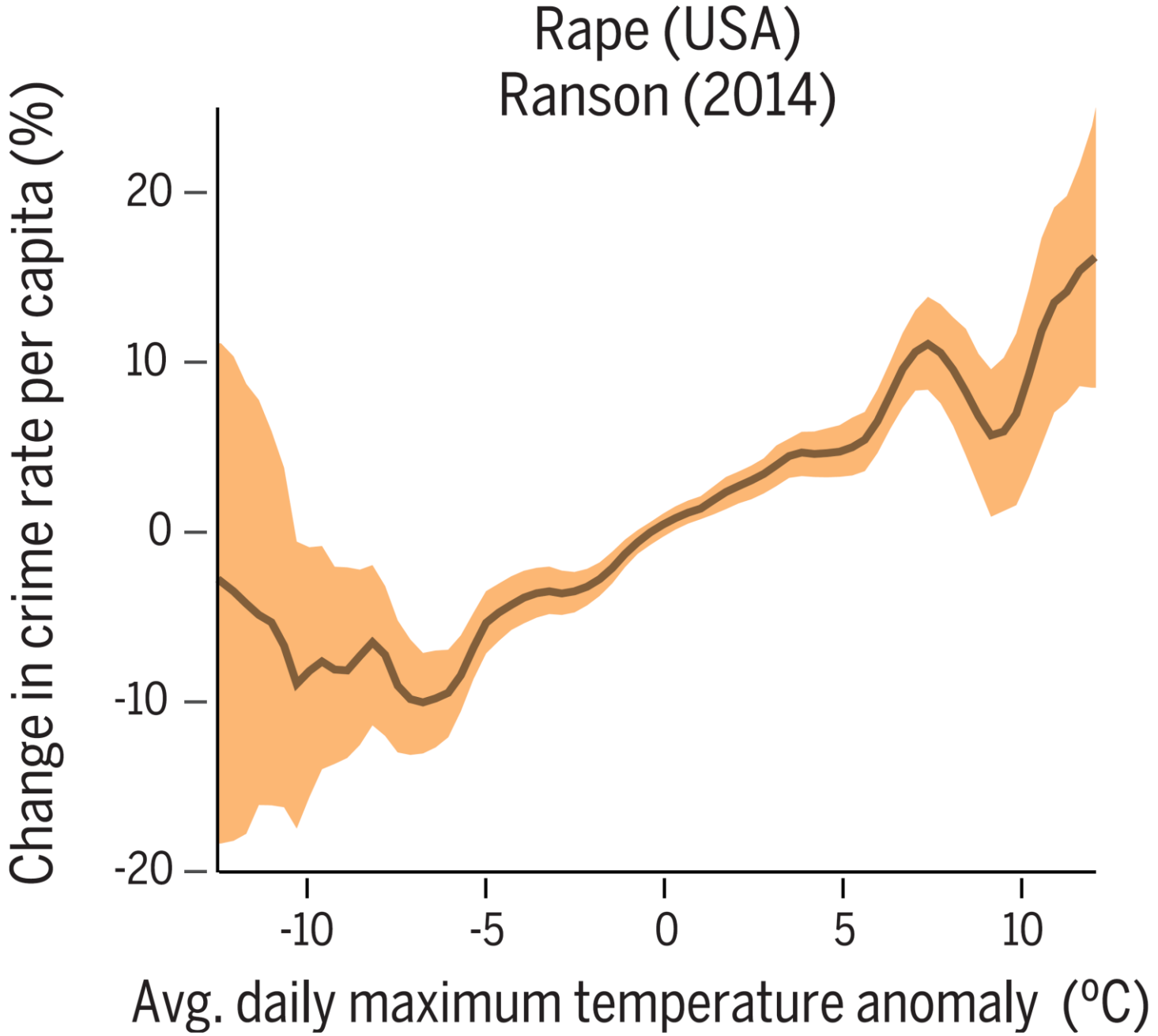


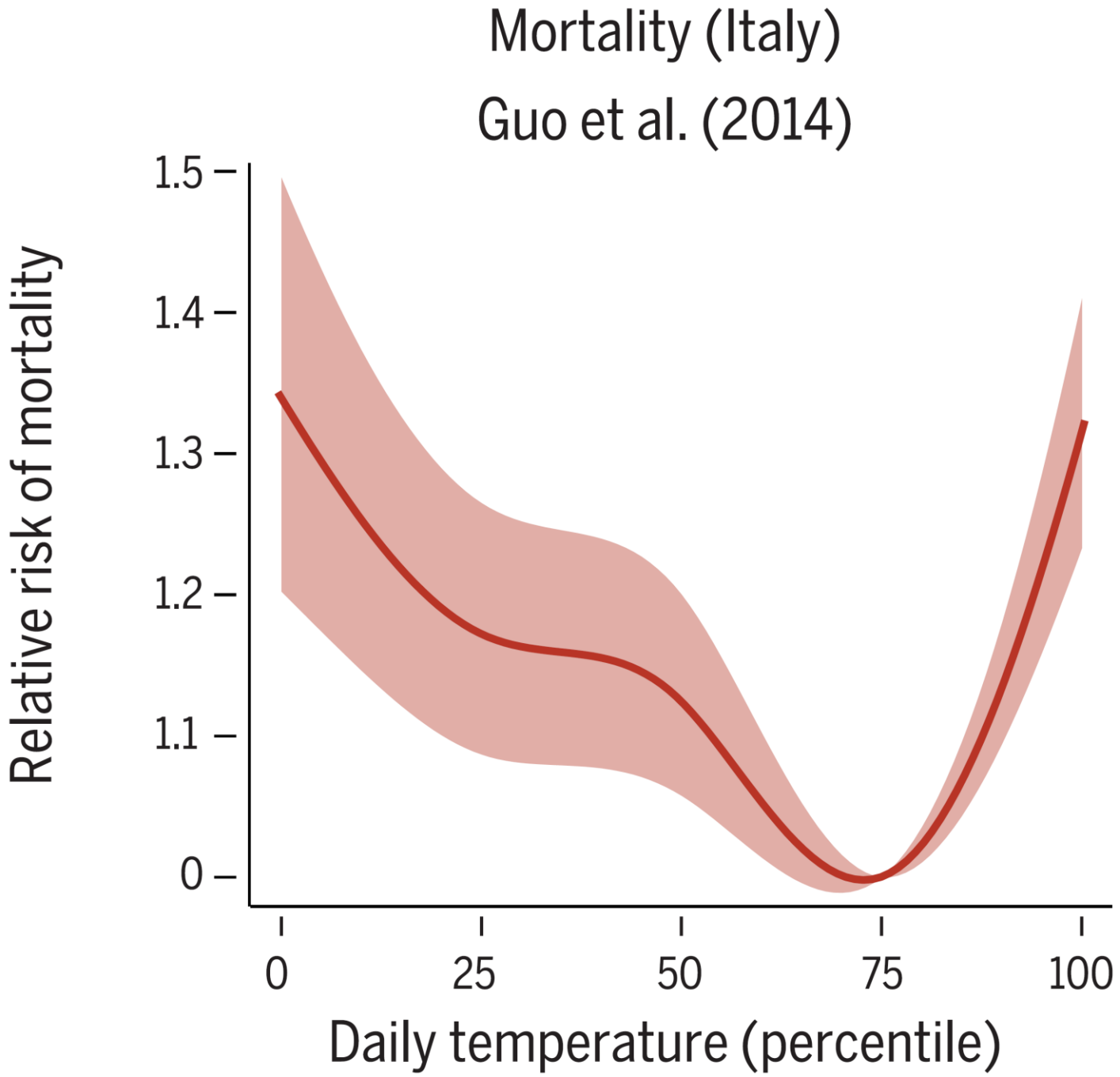

Total income per capita (USA)
Deryugina & Hsiang (2014)
Log annual total income per capita × 100
0
-0.05
-0.1
-10
-5
0
5
10
15
20
25
>30
Daily average temperature (°C)


Maize yields (USA)
Schlenker & Roberts (2009)
Log maize yield
0
0.025
0.05
0
10
20
30
40
Hourly temperature (°C)


Math test scores (USA)
Graff Zivin et al. (2015)
Change in child's test score (percentiles)
2
1
0
−1
−2
−3
−4
−5
−6
15
20
25
30
Daily average temperature (°C)

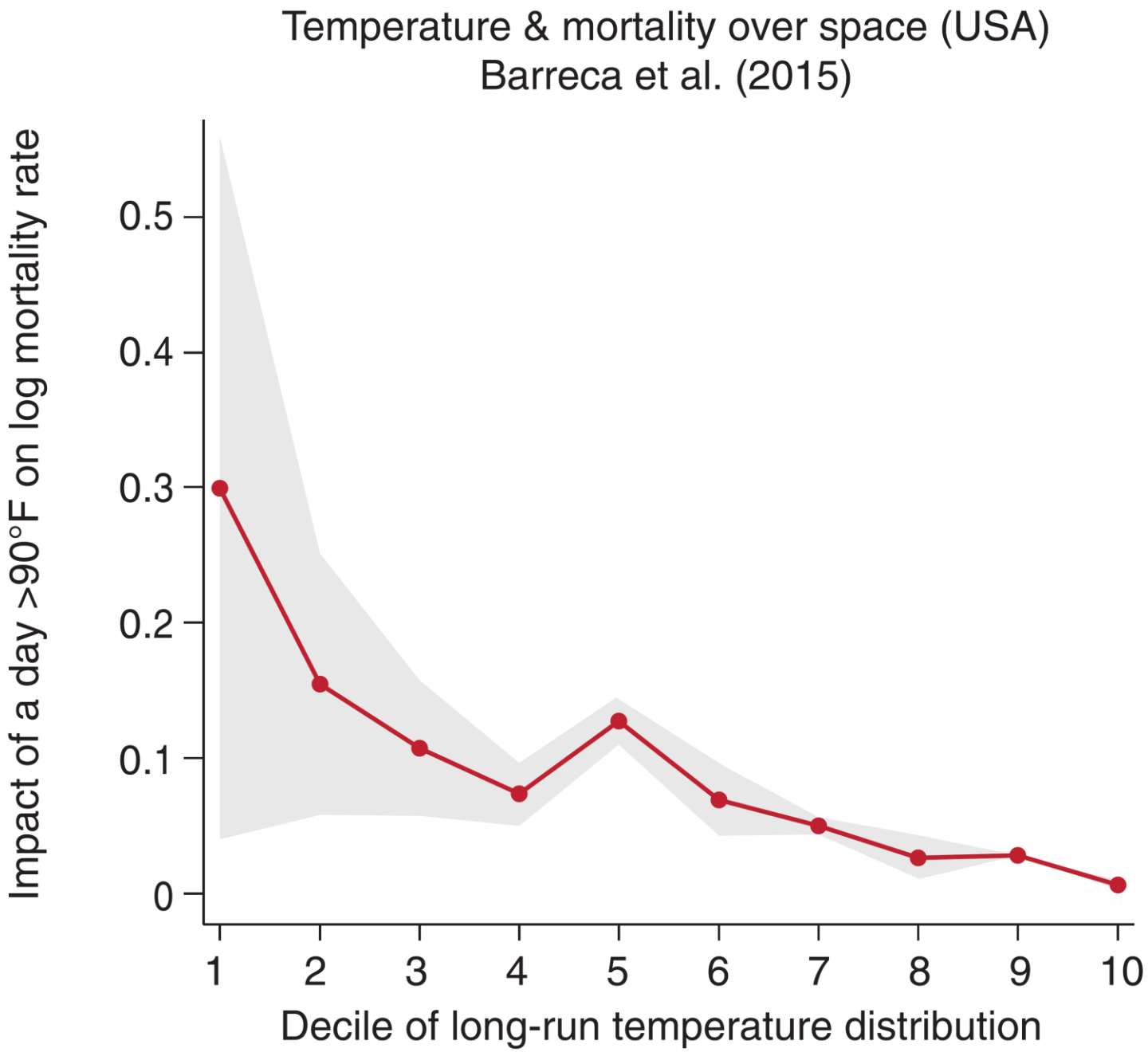

Profanity in social media (USA)
Baylis (2015)
Prob. profanity in social media post
0.020
0.015
0.010
0.005
0
-0.005
0
10
20
30
40
Daily maximum temperature (°C)

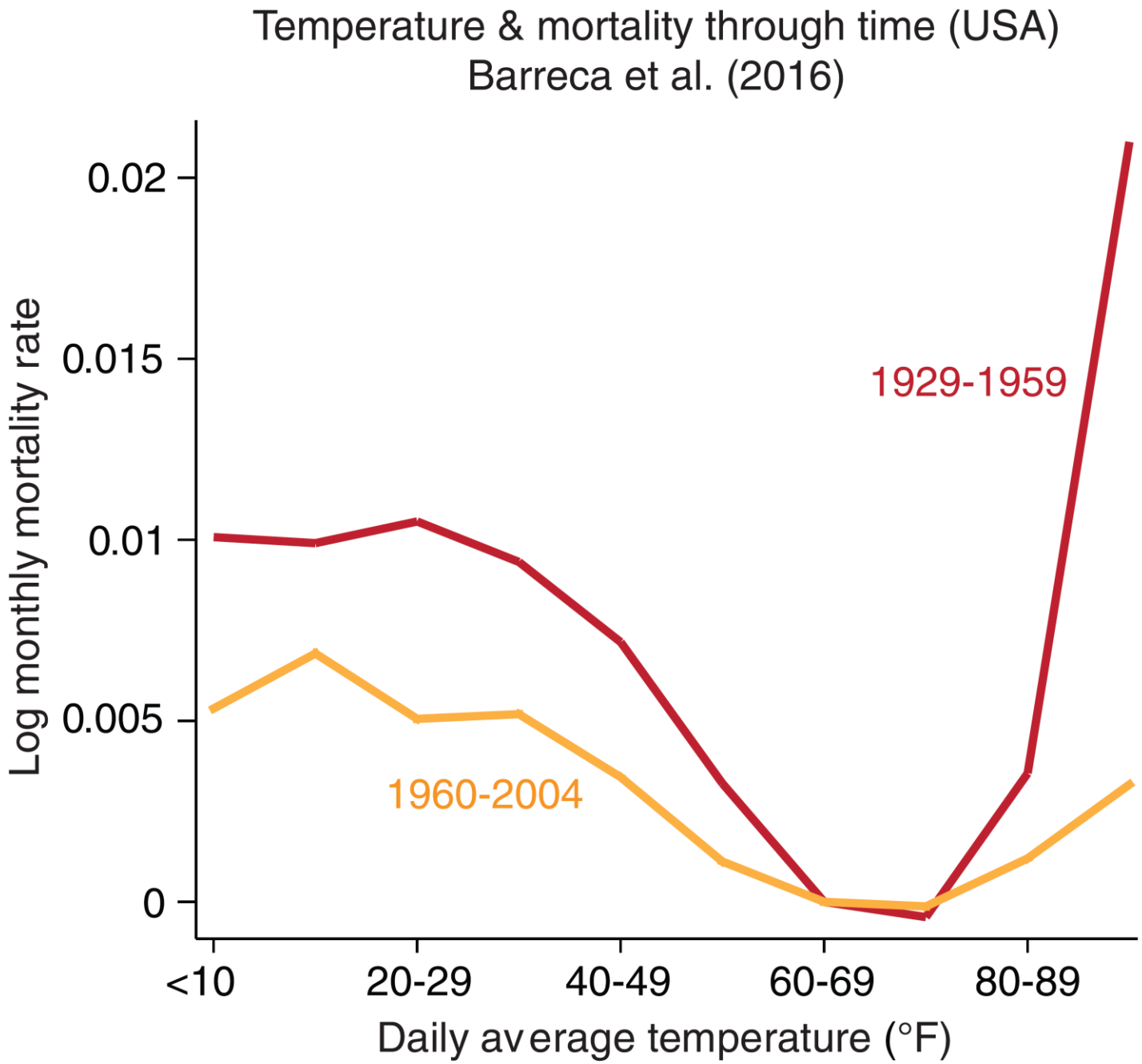

Rape (USA)
Ranson (2014)
Change in crime rate per capita (%)
20
10
0
-10
-20
-10
-5
0
5
10
Avg. daily maximum temperature anomaly (°C)


Mortality (Italy)
Guo et al. (2014)
Relative risk of mortality
1.5
1.4
1.3
1.2
1.1
0
0
25
50
75
100
Daily temperature (percentile)

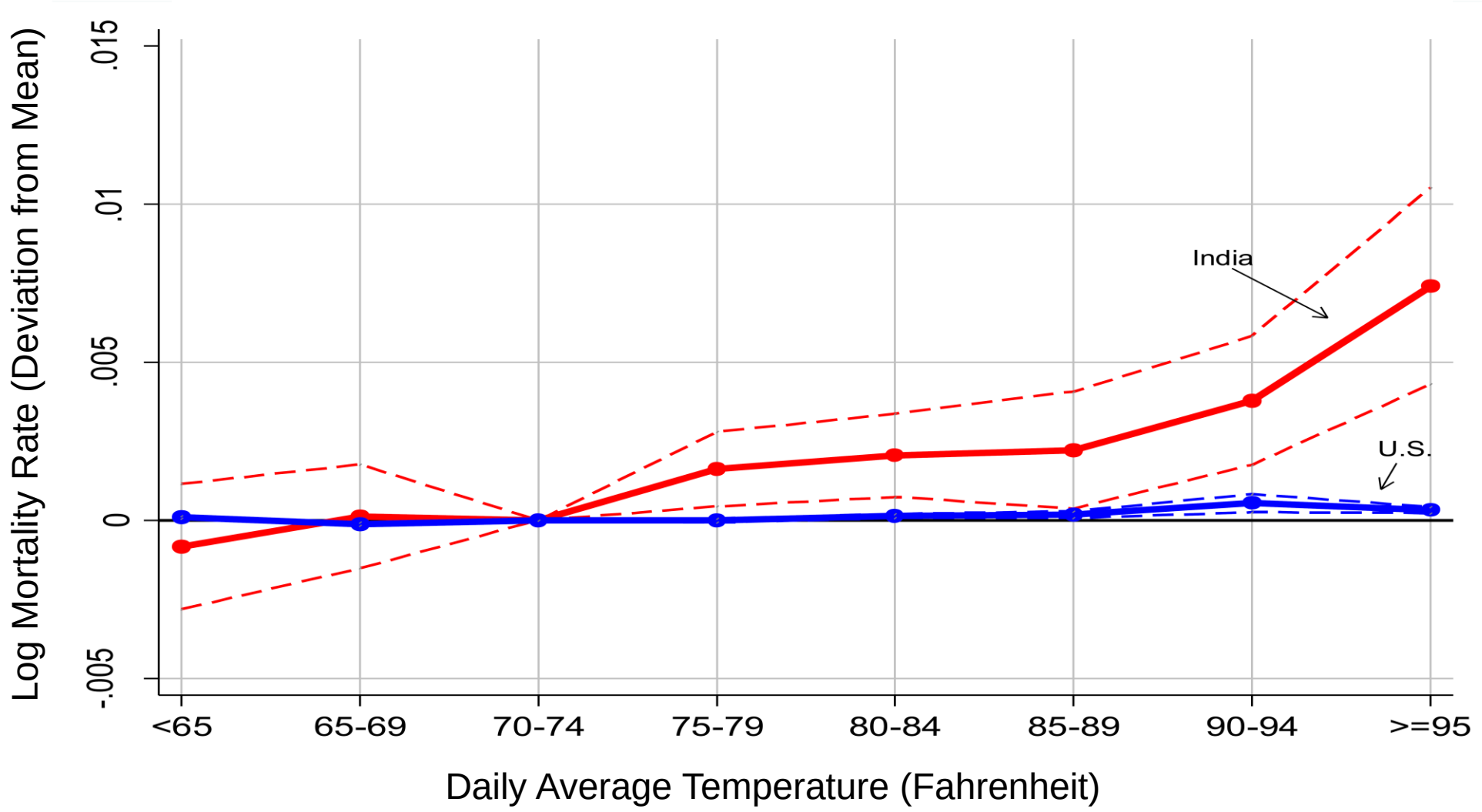
Effects of Adaptation

- How do these short-run impacts change if society has time to adapt?
- Challenge: difficult to directly identify causal impacts of long-term trends in climate
  - Lots of other things are changing as climate changes
- Instead, compare effects of short-run changes in places that have had time to adapt vs. places that have not
  - Ex: does a heat wave have smaller effects in areas that experience heat waves regularly?
  - Do temperature fluctuations have smaller costs in advanced economies?

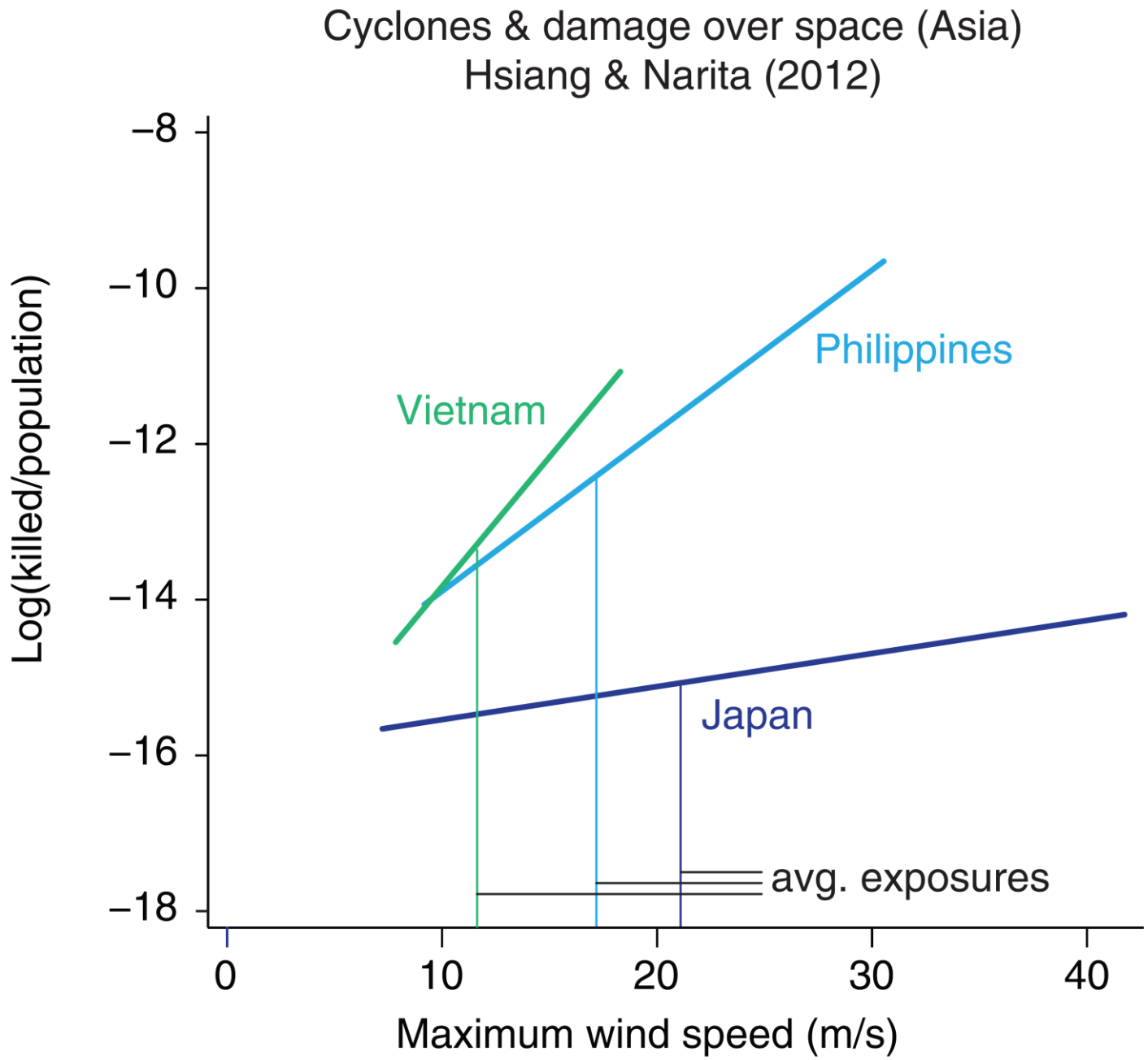

Temperature & mortality over space (USA)
Barreca et al. (2015)
Impact of a day >90°F on log mortality rate
0.5
0.4
0.3
0.2
0.1
0
1
2
3
4
5
6
7
8
9
10
Decile of long-run temperature distribution


Temperature & mortality through time (USA)
Barreca et al. (2016)
Log monthly mortality rate
0.02
0.015
0.01
0.005
0
1929-1959
1960-2004
<10
20-29
40-49
60-69
80-89
Daily average temperature (°F)

Impact of Daily Temperature Fluctuations on Mortality Rates in India vs. the U.S.



Source: Burgess, Deschenes, Donaldson, Greenstone 2017


Cyclones & damage over space (Asia)
Hsiang & Narita (2012)
Log(killed/population)
−8
−10
−12
−14
−16
−18
0
10
20
30
40
Maximum wind speed (m/s)
Vietnam
Philippines
Japan
avg. exposures

Estimating the Impacts of Climate Change

- Burke et al. (2015) results imply that predicted climate change by 2100 will lower global GDP by 23%

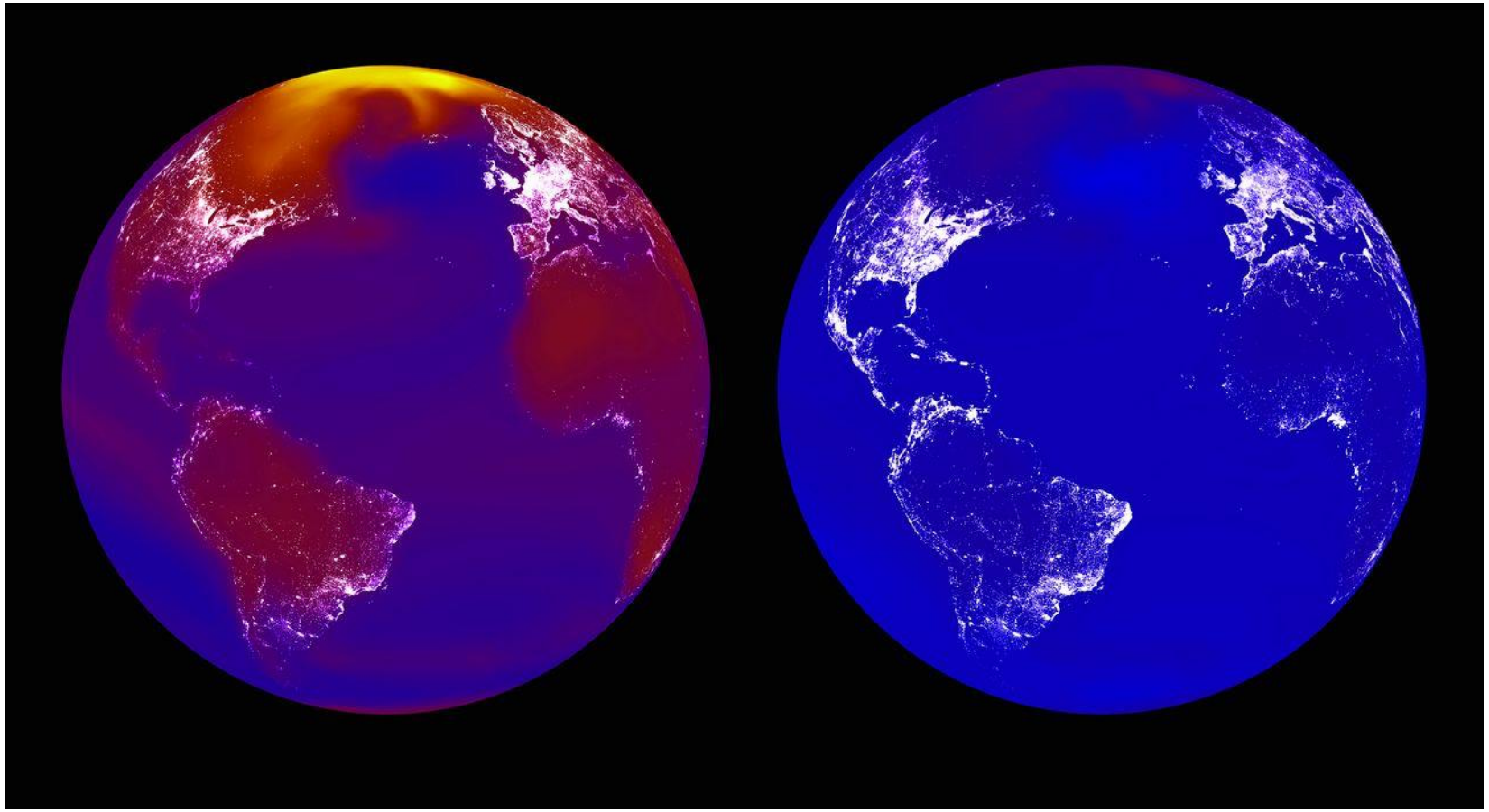
- This estimate is based on short-run fluctuations in temperature, though Burke et al. argue that long-term impacts are likely to be similar

  - No evidence that relationship between temperature and GDP has changed in recent years

- Further limitation of these measures: difficult to measure economic output systematically, especially in rural areas in developing countries

- Alternative approach: night-time light intensity, based on satellite images

Visualizing the Impacts of Climate Change Using Night-Time Light Intensity



Business as Usual

Stringent Emissions Reduction

Source: Carleton and Hsiang (*Science* 2016)

Impacts of Air Pollution

- Similar methods can be used to examine the impacts of other environmental damage

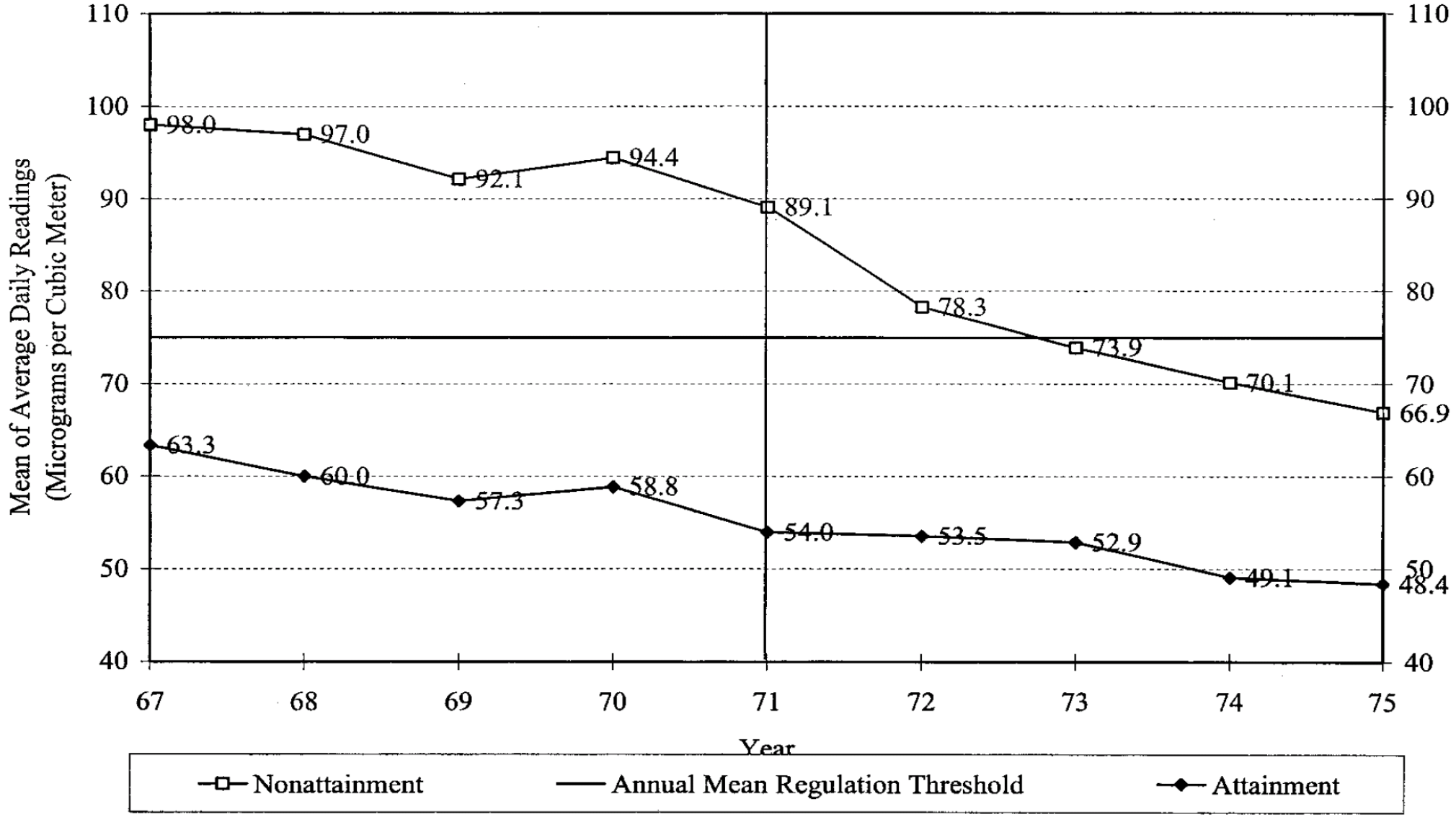
- Isen et al. (2014) examine impacts of air pollution on children's long-term economic outcomes

- Use administrative data from Census and tax records to examine how pollution in birthplace affects children's employment and earnings at age 30

Using the Clean Air Act to Estimate Causal Effects of Air Pollution

- Isen et al. exploit 1970 Clean Air Act to estimate causal effects of air pollution
- Clear Air Act placed a ceiling on total suspended particulates that all counties in the U.S. had to abide by
- Some counties were already below this ceiling, while others were not
- This led to differential changes in pollution across counties…

Impact of Clean Air Act on Air Pollution (Total Suspended Particulates)



Source: Chay and Greenstone 2005

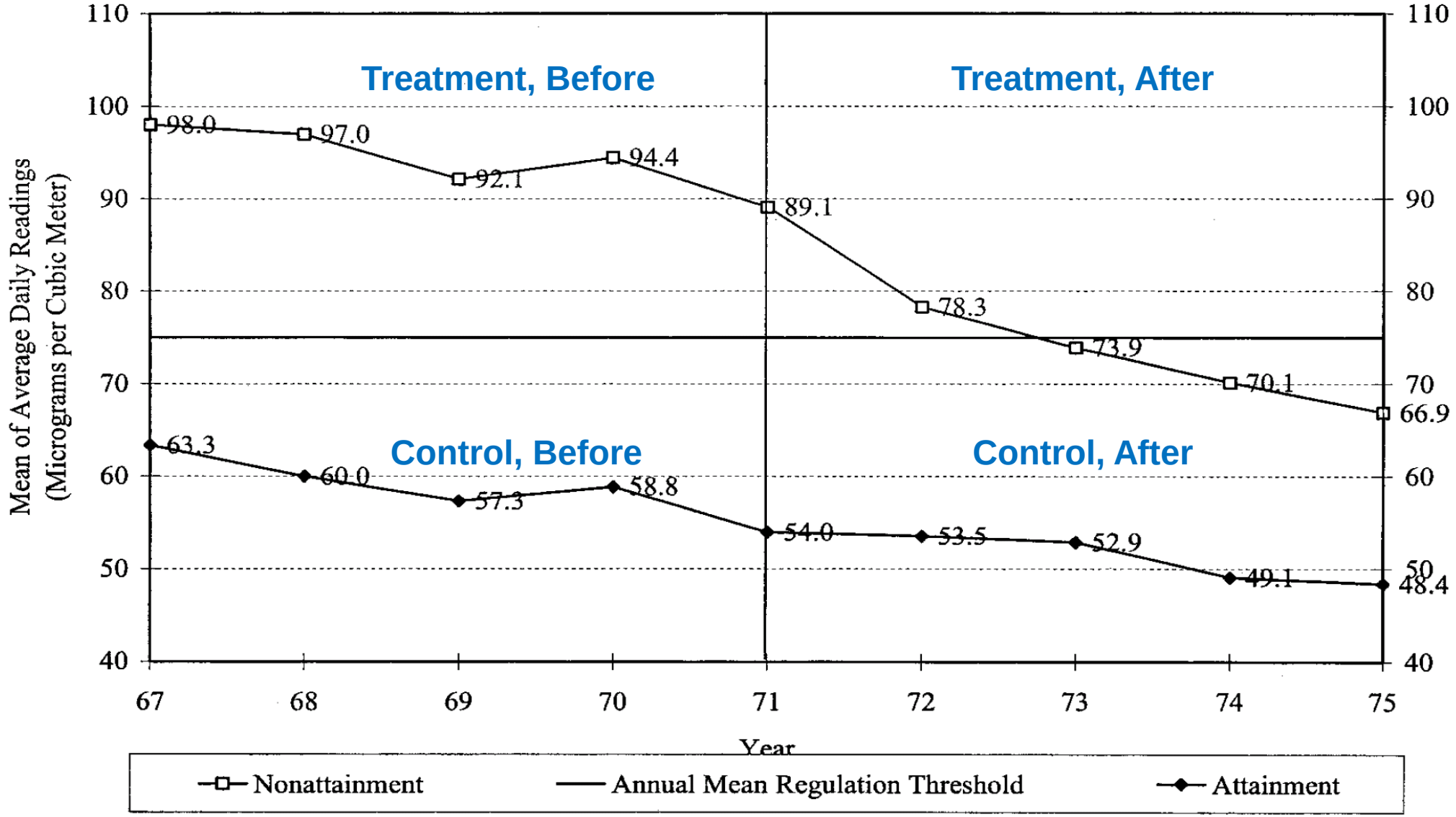
Difference-in-Differences Quasi-Experimental Methodology

- Exploit differential changes in pollution across counties to implement a **differences-in-differences** quasi-experimental research design

- Idea of diff-in-diff: approximate experiment by comparing an area that experienced a change (“treatment”) with an area that did not (“control”)

- Compare *differences* in outcomes in treatment area vs. control area, before vs. after policy change

Impact of Clean Air Act on Air Pollution (Total Suspended Particulates)



Source: Chay and Greenstone 2005

Diff in Diff Estimate = (TA – TB) – (CA – CB)

Difference-in-Differences Quasi-Experimental Methodology

- Diff-in-diff avoids biases that can arise from comparing different types of places or simply examining changes over time in a single place

- Key identification assumption to make diff-in-diff as good as an experiment: **parallel trends**

  - Absent the policy reform, outcomes would have changed similarly across the two types of areas

  - Does not necessarily have to hold, but can be evaluated by examining data *before* the policy change